

REMARKS

The Office Action dated January 24, 2007 for the above-identified patent application contained an objection to the specification as containing informalities in paragraphs [0027] and [0052]. The above amendment to the specification amends paragraphs [0027] and [0052] to correct in the manner suggested by the examiner to correct the cited informalities. No new matter is added. In view of the above amendments, Applicants request reconsideration and withdrawal of the objection to the specification.

Claims 1-24 were pending in the above-identified application when last examined and are amended as indicated above. The claim amendments clarify the claim language and are not intended to limit the scope of the claims, unless the claim language is expressly quoted in the following remarks to distinguish over the art cited.

Claims 1-7 were rejected under 35 U.S.C. § 101 as being directed to non-statutory subject matter. Applicants respectfully traverse the rejection.

Applicants wish to thank Examiners Mai T. Tran and Joseph P. Hirl for the telephone interview with Attorney, David T. Millers on April 23, 2007. During the telephone interview, this rejection under 35 U.S.C. § 101 and proposed amendments to claim 1 were discussed, but no agreement was reached regarding the patentability of any claims.

The Office Action near the top of page 3 sets forth a standard for statutory subject matter under 35 U.S.C. § 101. "The claimed invention must be for a practical application by: ... 2. having the FINAL RESULT (not the steps) achieve or produce a useful (specific, substantial, AND credible) concrete (substantially repeatable/non-unpredictable), AND tangible (real word/non-abstract) result." Applicants submit that claim 1 meets this standard.

Claim 1 has a final result of "the players contributing according to the results respectively assigned, the results designating whether respective players will cooperate in or defect from the cooperative effort." This result is useful because (as described in Applicants' specification) the result specifically addresses the substantial and credible need to determine whether people will contribute to a cooperative effort. The results are concrete in that selections by players cause repeatable results for contributions to the cooperative effort. The results are tangible in that players' contributions to a cooperative effort are real world activities, not mathematical abstractions.

Office Action beginning on page 10 raises the issue of whether “players” as used in claim 1 was tangible. In particular, the Examiner states, “all of the limitations of claim 1 such as ... “players” are disclosed theoretically or mathematically... Therefore, the Examiner’s broadest reasonable interpretation of the claimed invention is pure abstract ideas.”

Applicants’ specification in paragraphs [0002] and [0003] introduce the concept of players with reference to social choice problems or the public goods game. Paragraph [0002] states, “One well-studied classical game is the public goods game, which describes social choice problems involved in provisioning for public goods. A typical example of a public goods game arises for a group deciding whether to provide a common or public good, such as a park. The well-known free rider problem arises in such classical games when the best individual result is to avoid contributing to the purchase of a public good but to free ride on the benefits of the public good purchased by others. However, if too many players are free riders, the public good is not purchased. The free rider problem arises from the individual rational decisions of players to free ride resulting in the group as a whole being worse off than if all players had contributed.” Paragraph [0003] goes on to describe prior solutions to the free rider problem, for example, provided by government or altruism. Applicants submit that one of skill in the art upon viewing paragraphs [0002] and [0003] would interpret “players” as being people capable of making choices.

The Examiner cited paragraphs [0013] through [0016] as supporting a broad interpretation of the term “players.” Paragraphs [0013] through [0016] do describe quantum games mathematically, for example, by abstracting the choices available to each player. However, Applicants submit that the cited paragraphs nowhere indicate or suggest that players are merely abstract ideas. The Examiner’s interpretation of “players” as recited in claim 1 as being an abstract idea is not reasonable in view of claim 1 or Applicants’ specification. Claim 1 is thus directed to statutory subject matter.

Claims 2-7 depend from and inherit the elements of claim 1 and therefore also recited statutory subject matter.

For the above reasons, Applicants request reconsideration and withdrawal of the rejection under 35 U.S.C. § 101.

Claims 1-7 were rejected under 35 U.S.C. § 112, first paragraph, for lacking sufficient disclosure in the specification of how to practice the invention. In particular, the Office Action at the top of page 5 indicated, “Claims 1-7 are rejected under 35 U.S.C. §112, first paragraph because current case law (and accordingly, the MPEP) require such a

rejection if a §101 rejection is given.” For the reasons indicated above, claims 1-7 satisfy 35 U.S.C. § 101. Since no other lacking of the specification or claims was asserted in the rejection under 35 U.S.C. § 112, first paragraph, Applicants request reconsideration and withdrawal of this rejection.

Claims 1-24 were rejected under 35 U.S.C. § 102(a) as anticipated by “Experimental Implementation of a Quantum Game”, by Carsten Schuck, July 22, 2003 (hereinafter Schuck). Applicants respectively traverse the rejection.

Independent claim 1 distinguishes over Schuck at least by reciting, “constructing a state vector representing a plurality of pairs of entangled qubits.” Schuck fails to disclose or suggest use of a state vector including representing a plurality of pairs of entangled qubits.

Schuck is directed to an implementation of a quantum game and particularly to implementing a two person quantum game such as the quantum prisoner’s dilemma game. A two-person quantum game as Schuck discloses can be implemented using a single pair of entangled qubits. For example, Schuck on page 28, beginning at line 6 states, “The initial state of the classical game is a vector in the tensor product space spanned by the basis states $|CC\rangle$, $|CD\rangle$, $|DC\rangle$, $|DD\rangle$,” which are basis states of a pair of qubits. Beginning at line 13 of the same page, Schuck goes on to say, “Applying the entangling operator to the classical basis states then yields the four entangled basis states.” The four entangled basis states thus correspond to a single entangled pair of qubits. Schuck beginning at page 48, line 1, states, “states of the two-qubit system will be represented as vectors,” similarly referring to a single qubit pair.

Schuck does not disclose or suggest a technique for generalizing a quantum games from two players to n players. However, as disclosed in Applicants’ specification, one extension of a quantum game to n players would require extension to a state of n n-way entangled qubits, and the resources required to produce an n-way entangled state using conventional techniques grows exponentially with the number n of players. In accordance with an aspect of Applicants’ invention, the quantum resources required for a state representing a plurality of entangled pairs of qubits requires significantly fewer quantum resources (e.g., growing linearly with the number n of players) and is still able to reproduce a classical game in the limit that players make selections corresponding to the classical choices. Schuck only describes a two-player quantum game with a single entangled pair and nowhere suggests use of a plurality of entangled pairs in an n-player game.

For the above reasons, independent claim 1 is patentable over Schuck.

Claims 2-9 depend from claim 1 and are patentable over Schuck for at least the same reasons that claim 1 is patentable over Schuck.

Claim 2 further distinguishes over Schuck by reciting, "N is equal to n, and each player selects 2 of the 2N operators." Schuck discloses games where each player selects only one operator, which is for the one qubit corresponding to that player. For example, Schuck at page 28, line "Alice and Bob can manipulate their qubits by applying unitary operators \hat{U}_A and \hat{U}_B ... These operators represent local transformations acting exclusively on the qubits in Alice's and Bob's possession, respectively."

Claim 4 further distinguishes over Schuck by reciting, "N is equal to a product of $n(n-1)$ and a probability p, and p is less than 1." Schuck nowhere suggests such a relationship between the number N of entangled qubit pairs and the number n of players.

Independent claim 10 distinguishes over Schuck at least by reciting, "a source of multiple channels of entangled photon pairs." Schuck describes initial state preparation in section 3.1 and illustrates the process in Fig. 3.1. Fig. 3.1 shows a single channel for the entangled state $|\Psi_{IN}\rangle$ since the channel uses two optical fibers for spatial separation of the two photons in the pair. As noted above, Schuck discloses two player games using a single entangled qubit pair, and therefore only requires a single channel for a photon pair in an embodiment where a pair of photons represents the entangled qubits.

Claim 10 further distinguishes over Schuck by reciting, "a plurality of stations, where each station is associated with a plurality of the channels and is capable of performing a player-selected operation on states of photons associated with the station." Schuck discloses applying operators \hat{U}_A and \hat{U}_B on respective entangled photons in a single channel, e.g., as illustrated in Fig. 3.1, but Schuck fails to suggest any stations associated with multiple channels.

Claim 10 is thus patentable over Schuck.

Claims 11-24 depend from claim 10 and are patentable over Schuck for at least the same reasons that claim 10 is patentable over Schuck.

Claim 17 further distinguishes over Schuck by reciting, "the stations comprise n stations; and the channels comprise $p \cdot n(n-1)$ channels for a probability p less than 1."

For the above reasons, Applicants request reconsideration and withdrawal of the rejection under 35 U.S.C. § 102.

New claims 25 and 26 respectively depend from claims 10 and 1 and are

patentable for at least the same reasons that the respective base claims 10 and 1 are patentable.

In summary, claims 1-24 were pending in the application. This response amends claims 1 and 10 and adds claims 25 and 26. For the above reasons, Applicants respectfully request allowance of the application including claims 1-26.

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Respectfully submitted,



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